NOSW-3389

IN-46-CR

Jour. Geol. Soc. Jamaica, Vol. XXII, 1983

LUNAR AND PLANETARY INSTITUTE CONTRIBUTION NO. 468

STRUCTURE MODELS OF THE LOWER VERE PLAINS, JAMAICA

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Abstract

The results of a gravity survey from Harris Savannah to Portland Ridge have been used in conjunction with borehole information to construct models of the geological structure across the South Coast Fault Zone. Two models are presented here. The first explains the negative gravity anomaly across the Lower Vere Plains solely in terms of alluvium with a graben ($\sim$ 650 m required). The second model has a thinner alluvial layer ($\sim$ 100 m) within a graben with a total relief of about 2.5 km on the northern side and about 1.2 km on the southern side.

During 1977-78 thirty-nine new gravity stations were occupied in eastern Clarendon using the more widely spaced stations of the Andrew (1979) survey as reference stations. The object of this work was to provide data on the gravity anomaly that was thought might be associated with the South Coast Fault System which runs through the Lower Vere Plains. We present here an interpretation of the structure of this area that is consistent with these gravity data and the known geology.

GRAVITY MEASUREMENTS

The new measurements (Table 1) were made with a Worden gravimeter (Prospector Model 112). Station location uncertainties are very low; the area is covered with 1:12500 topographic maps with good photogrammetric control and most stations were sited at easily identifiable roadside features such as irrigation canals and crossroads where spot-heights (checked with a Paulin Terra altimeter) were available. The area is of very low relief and the terrain corrections were negligible for most stations.

ANOMALY MAPS

Both Free Air and Bouguer anomaly values were calculated. Figure 1, shows the Free Air anomaly map with the station numbers, whilst Figure 2, shows the Bouguer anomaly map. Datum for the Bouguer and terrain corrections is sea-level and a standard specific gravity of 2670 kg m^{-3} is assumed for all stations in contrast to Andrew who assumed local values for each station. In Table 1 we have corrected these stations to a standard S.G. for compatibility of these with the new data in the anomaly maps. The Free Air anomaly map shows that the general southerly gradient of gravity which dominates the southern side of the whole island of Jamaica (Andrew, 1969) is interrupted by the Lower Vere Plain gravity minimum. Because of the low topographic relief this pattern is little changed in the Bouguer anomaly map, which is very different from the Bouguer anomaly map for this region drawn by Andrew (1969). Andrew's map is drawn with a NE-SW gradient, but as can be seen from the new data this is incorrect. The ano-

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maly contours define a gravity low trending east-west, though the strong gradient to the south of the Brazilletto Mountains trends west north west. The gravity low in the Lower Vere Plains is compatible with an east-west structure controlled by the South Coast Fault System.

ROCK DENSITIES

A number of specimens of representative rock samples were collected from the area. The dominant exposed rock-type is limestone of the Newport Formation which crops out in the Brazilletto Mountains and Portland Ridge (Fig. 1). These chalky micrites of Miocene age are dolomitised in places, particularly around the Salt River Spring area. The Vere Plains themselves are covered by alluvium which is known to have a higher clay component, and hence a higher specific gravity, at depth (McFarlane, 1977). Finally the Pliocene Coastal Group limestones crop out along narrow belts at the Brazilletto Mountains, Kemp's Hill and Round Hill. Table 2, gives the specific gravities of these samples and the range of values reported by Andrew (1969) for the whole range of limestones of the White Limestone Group (of which the Newport Formation is the youngest).

STRUCTURE MODELS

Several two-dimensional structure models have been constructed, using density values based on the above data, to fit the gravity profile shown in Figure 2 (A-A'). Here we present two of these models. The essential feature to be modelled is the trough-like gravity low about 10 km across and with an amplitude of about 10 mgal. The first model (Fig. 3) is very simple and consists of a rectangular trough of alluvium 650 m deep and almost 7 km wide with a density contrast of 700 kg m^{-3} between it and the surrounding rocks. This model provides a reasonable fit to the width and amplitude of the gravity anomaly, but not to the shape. It is consistent with the measured density contrasts. The positions of the boundaries of the alluvium correspond to the inferred strike of the buried fault to the south of the Brazilletto Mountains (See McFarlane, 1977, Fig. 4) and the main fault on the north west side of Portland Ridge (see Wadge et al., 1979, Fig. 2). This model constrains the maximum depth of alluvium in the Lower Vere Plains to be 650 m.

Models involving more complex structure can only be justified if there is supporting geological evidence. Profile A-A' was drawn specifically to intersect the two main boreholes in the area; at Salt River and at Portland Ridge (Meyerhoff and Krieg, 1977). A model incorporating the sections from these boreholes is shown in Figure 4. At Salt River volcanic rocks of Paleogene?/Cretaceous age were drilled at about -300 m and similarly at Portland Ridge at about -2060 m. The Newport Formation also proved to be about 700 m thick in the Portland Ridge borehole. In this model the Cretaceous volcanic basement is assigned a specific gravity of 2700 kg m^{-3} ([illegible] 2670 kg m^{-3}), the Lower Tertiary (sub-Newport Formation) limestones a value of 2650 kg m^{-3}, the Upper Tertiary limestones (Newport Formation and Coastal Group) a value of 2500 kg m^{-3} and the alluvium a value of 2000 kg m^{-3}. The faulted boundaries of the previous model are retained and extended vertically downwards and a thickened Upper Tertiary section (arbitrarily placed at 1350 m thick) underlies a 100 m thick cover of alluvium. This thickness of alluvium is less than proven by boreholes around the Rio Minho further west but may be an appropriate figure for this area. The match of this model to the observed profile is superior to the simple alluvial model. It could be improved further but a more complex model is not justified without more gravity data and more geological control.

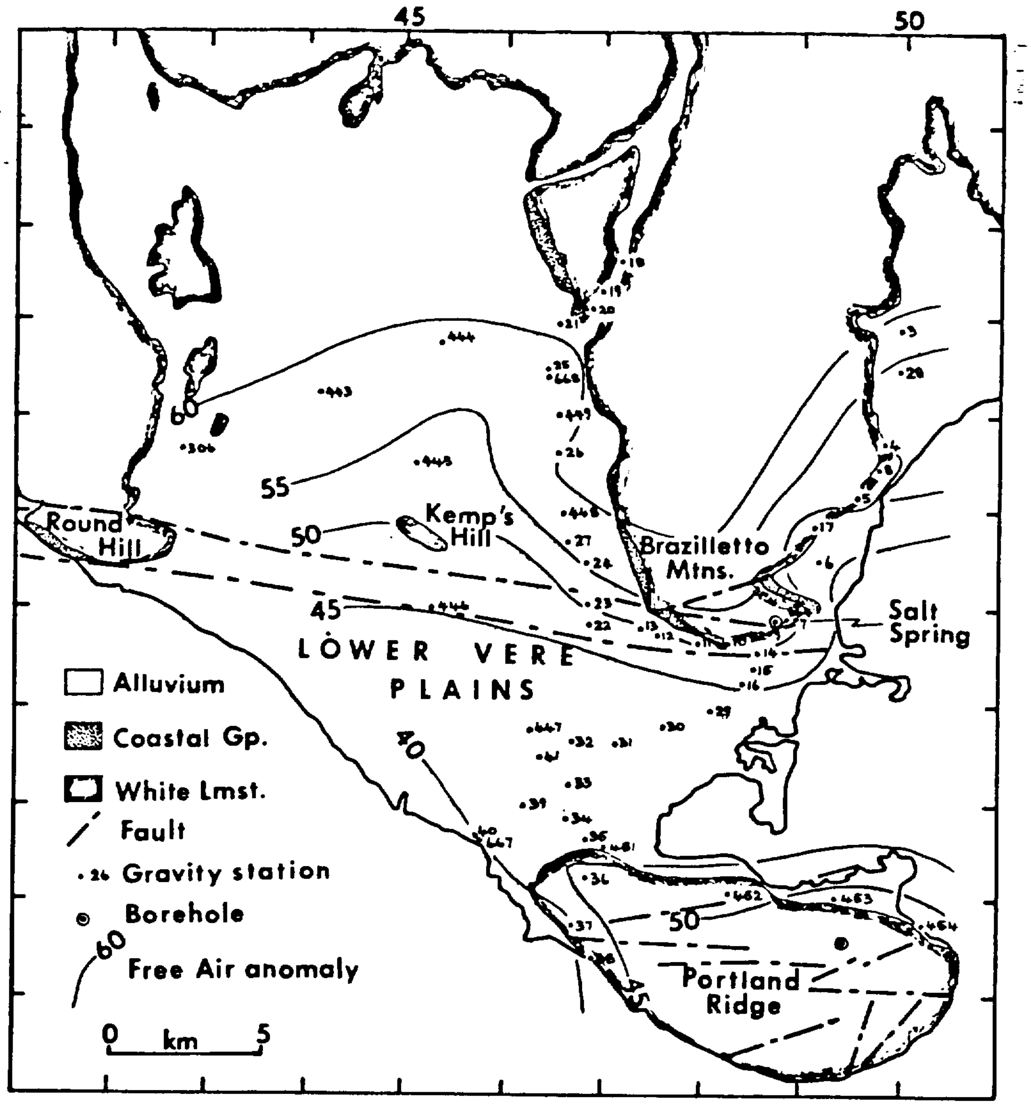

Fig. 1 Simplified geological map of the Vere plains of southern Jamaica with Free Air gravity anomalies contoured at intervals of 5 mgal. Faults are shown only for the southern half of the area.

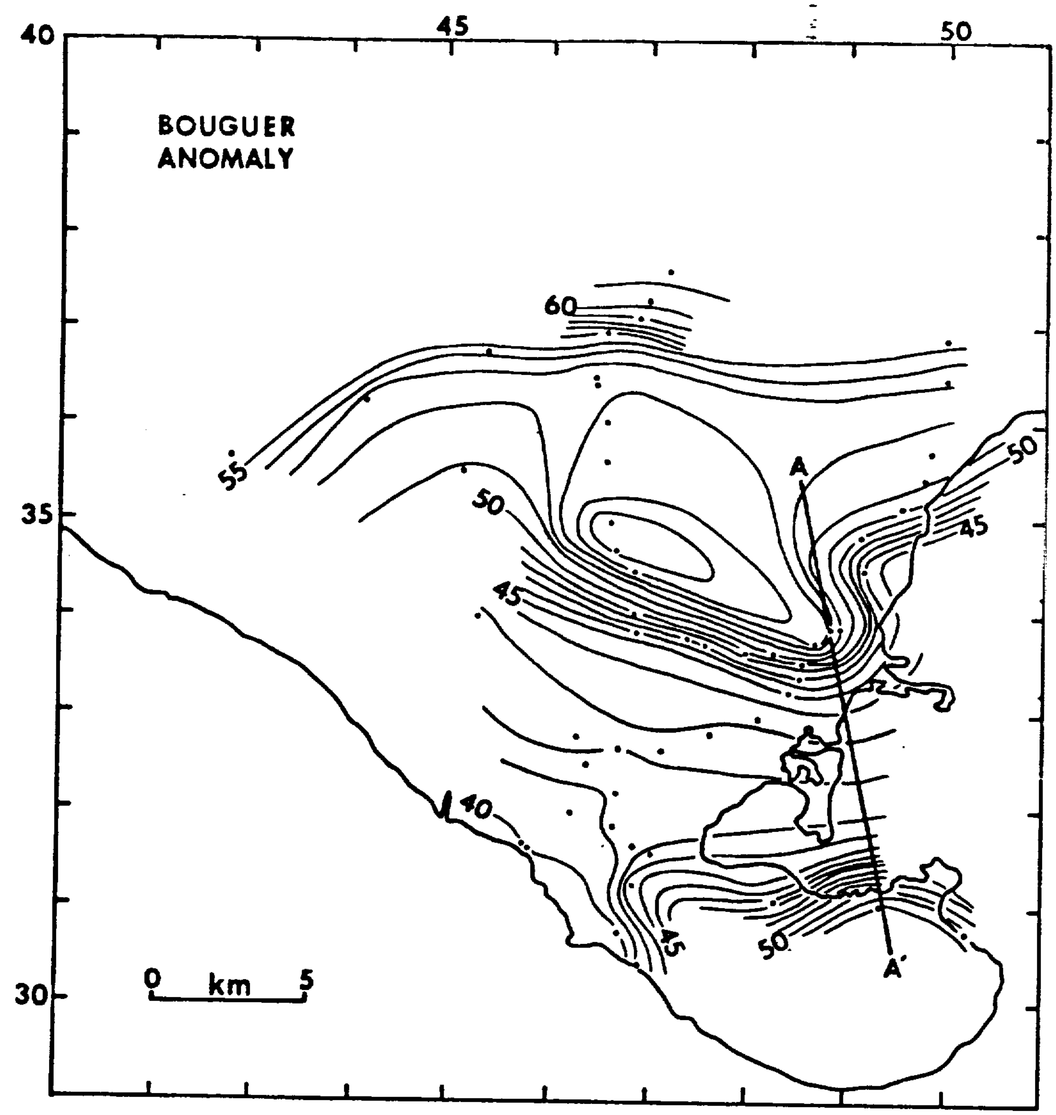

Fig. 2 Bouguer anomaly map of the same area as Fig. 1. Gravity stations shown as dots. Contours are in 1 mgal intervals and A-A' is the line of the profile used for structure modelling.

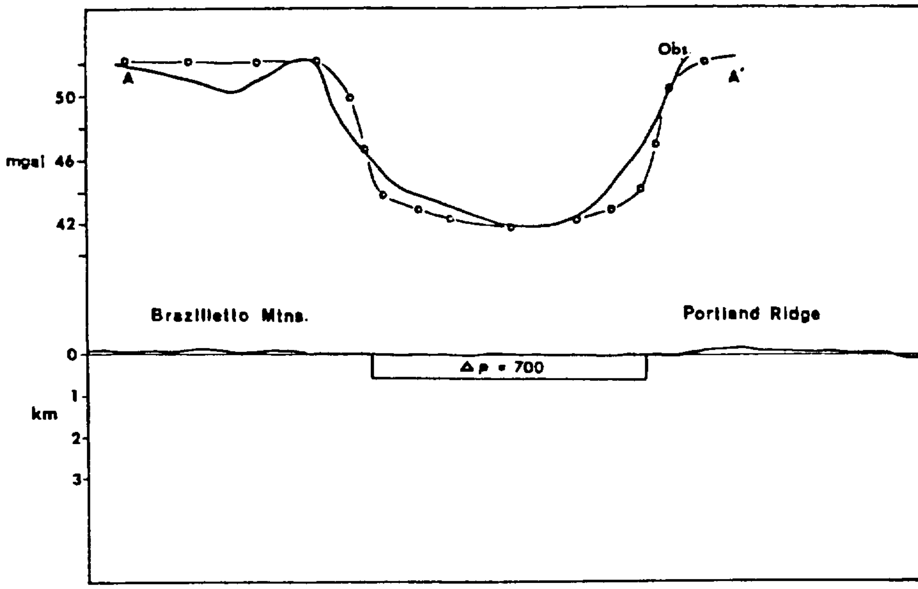

Fig. 3 Structure model corresponding to Bouguer anomaly profile A-A'.

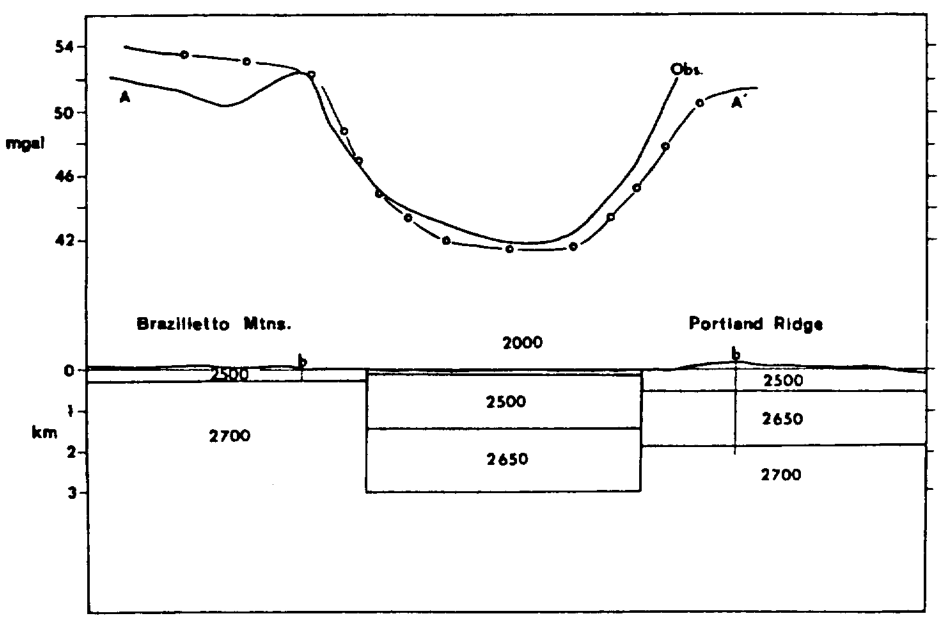

Fig. 4 Structure model corresponding to Bouguer anomaly profile A-A'. Specific gravities are in units of kg m^{-3}, b indicates Salt River and Portland Ridge boreholes.

DISCUSSION

An abrupt thickening of the alluvial cover, known from the many shallow wells bored on the Vere Plains, occurs south of a line joining Round Hill to the Brazilletto Mountains (Versey and Prescott, 1958). This alluvium is of Pleistocene age and represents the infilling of the structural depressions of the Upper and Lower Vere Plains. The Round Hill - Brazilletto Mountains line is on strike with the fault scarp of the Great Pedro Bluff further west and is the buried eastern extension of this fault scarp (Horsfield, 1974). Wadge et al., (1979) have argued that the lack of alluvial sedimentation in Portland Ridge's extensive cave systems means that Portland Ridge has been isolated from alluvial deposition since the Late Pliocene tectonism. Thus the fault(s) bounding the Lower Vere Plains to the south are at least latest Pliocene in age and judging from the folding and tilting of the Coastal Group rocks both the northern and southern boundaries of the Lower Vere graben were active tectonically during Plio-Pleistocene times.

The alluvium model indicates about 650 m of subsidence in about 2 m.y. (about 30 cm/1000 yr). The graben model is 3 km deep, but because the gravity model is very sensitive to the thickness of the alluvium component, and relatively insensitive to the contribution of the Lower Tertiary rocks this figure is only a rough guide. Nevertheless, cumulative vertical displacements of about 2.5 km on the northern boundary and 1.2 km on the southern boundary during the Plio-Pleistocene are indicated. The South Coast Fault System almost certainly has had a substantial strike-slip component of movement. Whilst recognising the importance of this we make no attempt to incorporate such movements into the models presented here.

References

Andrew, F.M., 1969. Gravity surveys in Jamaica. Inst. Geol. Sci., Geophys. Rept. No. GP/0/40, pp.32

Horsfield, W.T., 1974. Major faults in Jamaica. J. Geol. Soc. Jamaica 14, 1-14.

Meyerhoff, A.A. and Krieg, E.A., 1977. Jamaican petroleum potential. Oil and Gas J. Aug. 29, 1977, 79-85.

McFarlane, N., 1977. The non-carbonate Pleistocene sand deposits of the south-central coast of Jamaica. 10th. INQUA Conference, Birmingham, 1977.

Versey, H.R. and Prescott, G.C., 1958. Progress Report on the geology and ground water resources of the Clarendon Plains, Jamaica, W.I., Occ. Papers, Geol. Survey Dept. 1, 27pp.

Wadge, G., Fincham, A.G. and Draper, G., 1979. The caves of Jacksons Bay and the Cainozoic geology of southern Jamaica. Trans. British Cave Res. Assoc. 6, 70-84.

TABLE 1. GRAVITY READINGS IN SOUTHEASTERN CLARENDON, JAMAICA

Station	Grid Ref.	Height (ft.a.s.l.)	Observed Gravity (mgal)	Free Air Anomaly (mgal)	Bouguer Anomal (mgal)
UWI 3	4999 3688	37	978589.8	56.9	55.7
UWI 4	4984 3566	39	978583.8	52.9	51.7
UWI 5	4951 3512	20	978582.6	50.6	50.4
UWI 6	4918 3444	6	978577.8	45.4	45.3
UWI 7	4891 3389	10	978581.6	50.3	50.8
UWI 8	4973 3541	20	978584.8	52.3	51.8
UWI 9	4863 3372	15	978584.0	53.4	53.3
UWI 10	4826 3362	32	978579.6	50.8	50.2
UWI 11	4793 3361	51	978576.8	49.8	48.4
UWI 12	4751 3367	39	978576.3	48.1	47.0
UWI 13	4725 3371	43	978575.7	47.8	46.5
UWI 14	4851 3349	11	978579.8	49.2	49.0
UWI 15	4845 3335	11	978577.6	47.2	46.9
UWI 16	4834 3319	10	978576.1	45.8	45.5
UWI 17	4910 3482	9	978582.3	49.6	48.8
UWI 18	4709 3705	220	978585.4	68.8	61.4
UWI 19	4645 3722	199	978585.2	67.1	60.4
UWI 20	4679 3702	215	978582.9	66.5	59.3
UWI 21	4649 3690	183	978581.3	62.1	55.9
UWI 22	4633 3373	50	978574.8	47.5	45.8

UWI 23	4681 3402	52	978578.3	50.8	49.1
UWI 24	4679 3442	50	978583.9	55.7	54.0
UWI 25	4640 3643	150	978579.5	57.8	52.6
UWI 26	4655 3568	144	978581.3	60.1	53.2
UWI 27	4663 3466	90	978582.9	58.1	55.1
UWI 28	4997 3641	25	978587.4	54.0	53.2
UWI 29	4806 3291	11	978573.6	43.8	43.4
UWI 30	4755 3281	19	978572.3	43.4	42.8
UWI 31	4712 3265	16	978572.1	43.1	42.6
UWI 32	4665 3265	16	978571.4	42.4	41.9
UWI 33	4663 3236	3	978571.0	41.2	41.1
UWI 34	4660 3183	6	978570.2	41.4	41.2
UWI 35	4684 3162	5	978570.0	41.4	41.2
UWI 36	4680 3125	57	978569.1	45.9	44.0
UWI 37	4659 3074	1	978568.3	39.4	39.4
UWI 38	4685 3044	0	978568.8	41.4	41.4
UWI 39	4619 3202	11	978570.2	41.0	40.6
UWI 40	4570 3163	3	978568.5	39.7	39.6
UWI 41	4644 3247	9	978570.9	41.5	41.2
306*	4270 3560	62	978586.8	58.1	56.5
443*	4410 3621	105	978581.6	56.1	52.7
444*	4530 3669	131	978582.8	59.0	54.5
445*	4508 3545	102	978579.0	54.3	50.9
446*	4523 3398	61	978571.3	44.9	42.8

447*	4625 3275	30	978571.2	43.6	42.6
448*	4657 3494	104	978583.0	59.2	55.7
449*	4649 3601	138	978580.2	58.0	53.4
451*	4702 3155	6	978570.5	42.4	42.2
452*	4821 3105	9	978573.4	46.3	46.4
453*	4932 3104	6	978579.5	52.1	52.5
454*	5021 3077	2	978578.6	51.2	51.4
664*	4883 3388	6	978583.5	52.0	52.4
667*	4572 3163	147	978568.8	40.2	40.1
668*	4642 3634	2	978579.6	57.8	52.8

* Andrew (1969) station

TABLE 2. SPECIFIC GRAVITY DETERMINATIONS OF ROCKS FROM SOUTHEASTERN CLARENDON

Rock type	S.G. (kg m^{-3})	No. of samples
Alluvium	1700	2
Coastal Group	2410	2
Newport Fm.	2490	3
Partly dolomitised Newport Fm.	2520	3
Totally dolomitised Newport Fm.	2600	1
Tertiary Limestones (Andrew,1969)	2610 (2510-2670)	10